

THE MICROBIOLOGY OF CANNED FOODS

BY

CHARLES MARSHALL WILSON

A.B., University of Illinois, 1938

M.S., University of Illinois, 1940

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN BACTERIOLOGY
IN THE GRADUATE SCHOOL OF THE UNIVERSITY
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THE MICROBIOLOGY OF CANNED FOODS

When Nicolas Appert founded the canning industry, the importance of bacteria was unknown. Spoilage of foods in what were believed to be hermetically sealed containers was attributed to other causes. Not until 1895 did canned food processors suspect that bacteria were involved. The early investigations were little more valuable than to show that bacteriology might be of some help. The earliest investigations revealed the presence of organisms which are not recognized today as very important as causes of spoilage.

The first significant advance in bacteriology was the discovery by Barlow (1913) at the University of Illinois that bacteria whose optimum temperature for growth is at 55°C. (131°F.) could develop in canned corn when it was stored at too high temperatures. Barlow's observations have been confirmed and extended so that canners have had to recognize thermophilic bacteria as a great problem in the canning industry. Much experimental work and many publications, especially from the Research Laboratory of the National Canners Association, have warned vegetable canners of thermophilic spoilage hazards. In spite of control measures furnished to the canners, these organisms have not been eliminated from canned non-acid vegetables and thermophilic spoilage is still an ever-present threat.

In the early days of thermophilic spoilage control, emphasis was placed on the importance of soil as the primary source of contamination; discovery of the contamination of sugar with these organisms, opened an entirely new approach for their control. It is now believed that the ingredients and equipment used in the canning operation are the real sources of thermophilic contamination. Since the publication of the first standards for canning sugar by the National Canners Association in 1931, threat of contamination from sugar has been greatly lessened.

The entire problem of thermophilic spoilage in canned food will not be solved until equipment is developed which is simple to operate and clean, and the true importance of these organisms is brought home to every vegetable canner.

During the canning seasons of 1944 and 1945 surveys were made in connection with the U. S. Army Quartermaster Corps Subsistence Research and Development Laboratory, in 272 corn canneries and more than 300 pea canneries. In the cream style corn canning operation, samples were taken from the silkers, batch mixers, preheaters, brine, unprocessed line and processed cans. In the whole kernel corn canning operation, samples were obtained from fillers, brine, unprocessed line, and processed cans. Samples of vacuum pack operation were exactly the same as listed for whole kernel corn. In the pea canning operation, samples were taken from the blancher, washed peas, brine, unprocessed line, and processed cans. All samples except the processed cans, were cultured for the three general types of thermophilic spoilage organisms: (1) flat sour, (2) thermophilic anaerobe not producing hydrogen sulfide, commonly called thermophilic anaerobe or "T.A.," and, (3) thermophilic anaerobe producing hydrogen sulfide, commonly called "sulfur stinker." Samples to be examined for flat sour spores were cultured in Difco, Dextrose Tryptone Agar; samples examined for thermophilic anaerobes were cultured in a tryptone broth as suggested by the National Canners Association Research Laboratory; the presence of sulfide spoilage spores was determined by culturing samples in tubes of agar containing tryptone, sodium sulfite, and iron citrate. All cultures were incubated at 55°C. (131°F.) for 48 hours. Before culturing, all samples were submitted to 180°C. (227°F., approximately 5 pounds steam pressure) for ten minutes to destroy any non-heat-resistant organisms that might be present. Processed cans were incubated at 55°C. (131°F.) for four days before being examined for spoilage. Thermophilic spoilage organisms were found in many instances, not only in the various pieces of equipment and at different stages in the canning operation, but also in the processed cans as demonstrated by actual spoilage after incubation. "Flat sour" type organisms and spoilage were by far the most prevalent. In cream style corn, the spores of the "flat sour" bacteria were found in 8.86 per cent of 158 samples of cut corn; 15.08 per cent of 358 samples from batch mixers; in 22.67 per cent of 463 samples from preheaters; in 16.93 per cent

of 183 brine samples; in 24.52 per cent of 318 unprocessed line samples; and flat sour spoilage developed in 8.53 per cent of 3,080 incubated processed cans. Spores of thermophilic anaerobes were rarely found and no spores of the sulfide spoilage organism could be demonstrated.

In whole kernel corn, evidence of flat sour organisms was found in 10.73 per cent of 354 samples of cut corn; in 8.05 per cent of 236 brine samples; in 31.39 per cent of 258 unprocessed line samples; and flat sour spoilage developed in 8.29 per cent of 3,124 incubated processed cans. Again spores of the thermophilic anaerobe were rarely found and no spores of the sulfide spoilage organisms were revealed.

In vacuum pack corn, flat sour spores were found in 1.61 per cent of 124 cut corn samples; in 8.21 per cent of 73 samples of brine; in 13.39 per cent of 112 unprocessed line samples; and only 1.95 per cent of 1,073 incubated processed cans developed flat sour spoilage. Thermophilic anaerobe spores were only occasionally found and no sulfide spoilage spores were noted.

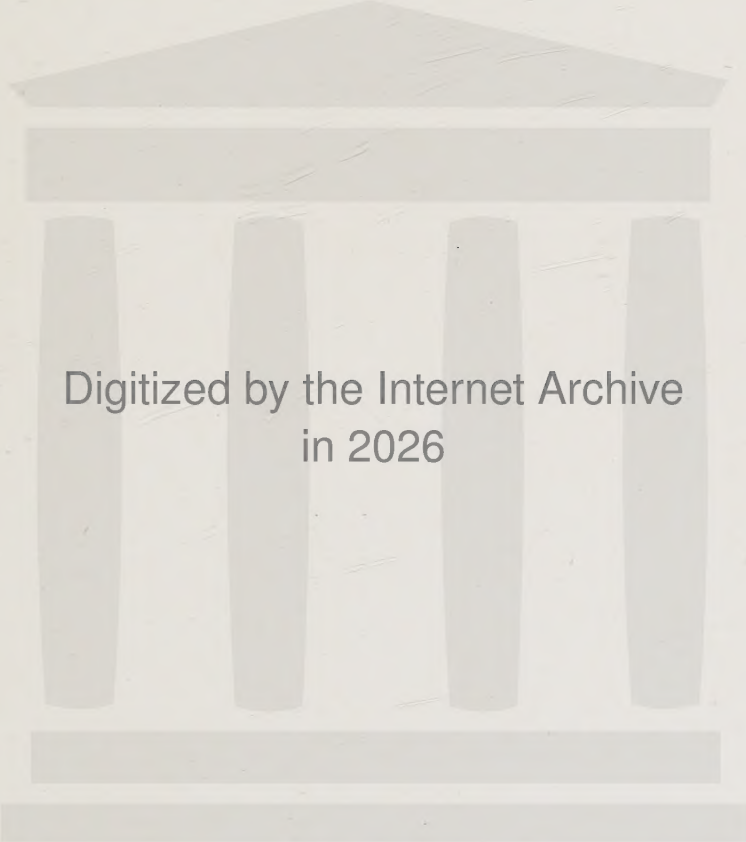
In the canning of peas, flat sour spores were demonstrated in 88.90 per cent of 1,055 samples of water from blanchers; in 33.52 per cent of 1,038 samples of washed peas; in 20.08 per cent of 473 brine samples; in 42.47 per cent of 1,090 unprocessed line samples; and flat sour spoilage was proven in 19.73 per cent of 9,654 incubated processed cans. Thermophilic anaerobe spores were present in 1.32 per cent of the samples of blancher water, but were found in less than one-half of one per cent in all other samples. The only evidence of sulfide spoilage organisms was the development of this type of spoilage in one incubated processed can.

From the data gathered in this work, it would appear that the occurrence of thermophilic spoilage organisms in peas and corn canning operations cannot be denied. The existence of "commercial sterility" is again confirmed as witnessed by the thermophilic spoilage of incubated processed cans of peas and corn.

VITA

The author was born July 22, 1915, in East St. Louis, Illinois. He attended elementary and secondary schools in East St. Louis, Collinsville, Highland, and Vandalia, Illinois. He was graduated from the Vandalia High School in 1932. The degree of Bachelor of Arts was received from the University of Illinois in 1938 and the Master of Science degree in 1940 from the same institution. From September, 1938 until February, 1940, he was a research assistant in Home Economics, and from February, 1940 until March, 1942, he was an assistant in Animal Pathology and Hygiene. He was called to active duty with the Armed Forces in March, 1942, and served until February, 1946. All except two months of this time was spent in the United States Army Quartermaster Corps Subsistence Research and Development Laboratory in Chicago, Illinois.

He is a member of Sigma Xi, Phi Sigma, the Society of Illinois Bacteriologists, the Society of American Bacteriologists and the Institute of Food Technologists.



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